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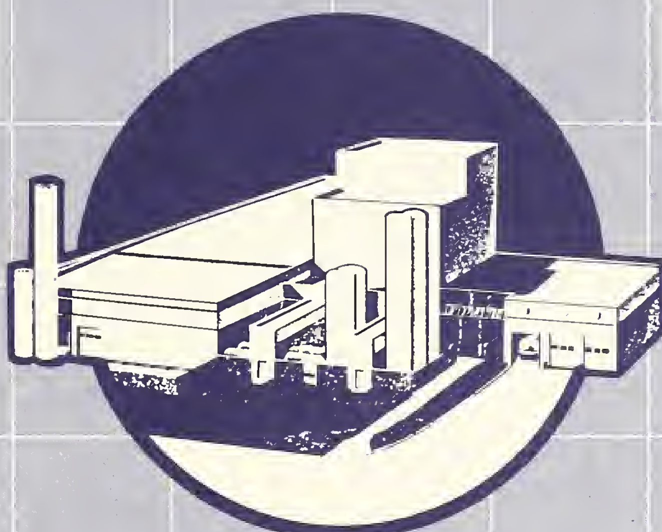
Pricing Plans for Managing Seasonal Deliveries by Dairy Cooperatives



Abstract

Pricing Plans For Managing Seasonal Deliveries By Dairy Cooperatives. K. Charles Ling, Cooperative Marketing and Purchasing Division, Agricultural Cooperative Service, U.S. Department of Agriculture, ACS Research Report 22.

This study develops a method to devise pricing plans for dairy cooperatives to recover costs of handling seasonal milk deliveries from producers and the cost of satisfying handlers' cyclical fluid demand. Based on analyses of hauling and manufacturing costs, charges against producers and handlers are formulated. Manufacturing cost is the major component of producer charges. Give-up charges against handlers are determined by the cooperative's manufacturing cost, while hauling cost is the main consideration in servicing handlers' day-to-day fluctuation of fluid demand.

Keywords: Milk, seasonality, pricing plans, hauling cost, manufacturing cost, give-up charges.

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Preface

The main objective of this research is to devise pricing plans to enable dairy cooperatives to better serve producers and handlers in the dairy industry. Associated with this aim are the following goals:

- Determine the best seasonal pattern of milk production by comparing hauling and manufacturing costs.
- Determine the most appropriate and equitable pricing plan for the cooperative to use to pay for handling members' seasonal milk deliveries.
- Determine a means to calculate give-up charges for diverting milk from manufacturing plants for sales to handlers.
- Determine a means to calculate charges to handlers that require certain fluctuations in daily deliveries.

The study focuses on a hypothetical model ABC Cooperative facing assumed seasonal and daily patterns of fluid demand and an assumed seasonality of milk production. The full-service coooperative operates a butter-powder manufacturing plant to balance milk supply. Principles developed from this hypothetical model can be adopted by dairy cooperatives to apply to their specific situations, for example, multiple plants or multiple products operations.

To achieve the objectives, the following steps were followed:

- The seasonal pattern of fluid milk demand facing ABC Cooperative was determined. The seasonal pattern of fluid milk consumption based on Federal Order No. 2 market area data 1976-80 was used. The seasonality of milk production for the same time period was also determined. The assumed seasonal pattern for ABC Cooperative was the seasonality of milk production in New York State.
- Hauling costs for different seasonal patterns of milk production, given the annual total volume produced, were determined.
- Sizes and costs of manufacturing plants to process milk in excess of fluid uses under different seasonal patterns were determined.
- By considering both hauling and manufacturing costs, the best seasonal pattern of milk production, which would yield overall efficiency and least-cost operations for the cooperative, was determined.
- Based on the principle of service at cost, an equitable pricing plan for producers was determined.
- Based on unit manufacturing costs at different volumes of milk, a schedule of give-up charges to handlers for diversion of milk from the manufacturing plants was developed.
- A method of determining charges to fluid milk handlers for fluctuation of daily receipts was developed.

Highlights

Dairy cooperatives incur substantial costs in handling seasonal deliveries. Milk production peaks in spring and bottoms out in fall. Fluid demand is higher in early spring and fall than in summer and winter. The weekly cycle of fluid demand by handlers further complicates the problem of reserve balancing operations. This study analyzes effects of such cyclical fluctuations on cooperatives' hauling and manufacturing costs. Based on the principle of service at cost, pricing plans are recommended to recover these costs through charges on excess seasonal milk volume that causes seasonal balancing problems.

Milk production that conforms to fluid demand is the most desirable production pattern for combined hauling and manufacturing costs. The production pattern, therefore, serves as the norm against which costs of handling seasonal excess milk are assessed. Seasonal excess milk costs an extra 87 cents to $1.27 per hundredweight to handle, mainly in extra manufacturing costs. The extra cost should be charged against the seasonal excess milk volume.

A cooperative should assess a give-up charge to a handler, if a shipment of milk to satisfy a handler's demand reduces the milk volume at the cooperative's reserve manufacturing plant below its rated capacity. The give-up charge on the milk volume shipped should be the same as the per-hundredweight fixed manufacturing cost calculated at the rated capacity.

The weekly cycle of fluctuating fluid demand by handlers mainly affects hauling cost. The impact on hauling cost depends on the relative distance between the manufacturing plant and the milk supply area, and between the supply area and fluid demand centers.

The proceeds from pricing plans should not be distributed to producers through the monthly milk pool. The proceeds should be kept by the cooperative to defray operating costs. Any increased net savings as a result will be shared by producers through patronage refunds.

This study was based on a hypothetical model cooperative whose members delivered an average 4 million pounds of milk a day. On the average, half the milk was for fluid utilization and the rest for manufacturing at the cooperative's own plant.

A different set of data on milk volumes and costs might change the findings. Application of the methodology to a specific cooperative requires a careful cost analysis of a cooperative's hauling and manufacturing operations.

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MANAGING MILK DELIVERIES

Seasonal fluctuations in milk production cause operational problems for dairy cooperatives. They require cooperatives to haul fluctuating volumes of milk with expensive equipment, some of which is underutilized part of the year, resulting in high hauling costs. To a cooperative engaged in manufacturing operations, especially manufacturing hard products, which are the markets of last resort, seasonal milk volume affects capacity utilization of plants and unit costs of final products. During the spring flush, manufacturing plants are flooded with milk pressing on their operating capacity. In fall, many of these plants operate at a much lower capacity and some are even idled. The situation presents dairy cooperatives with problems of managing costly hauling and manufacturing operations.

Two major seasonal milk pricing plans are traditionally used, primarily in regulated markets, to provide incentives for farmers to reduce seasonal production fluctuation: base-excess plan and seasonal incentive (Louisville) plan. With the base-excess plan, a producer receives a lower (usually Class II or III) price for all milk in excess of a delivery base established during a base-forming period. Any remaining value based on use made of the milk is divided among base milk. The purpose is to stabilize seasonal production around the base.

The Louisville plan sets up a seasonal incentive fund by deducting a specified amount from milk pay price during the spring months. The sum of the fund, plus interest earned, is included in the pool prices paid during the fall months. The plan attempts to discourage production during the spring flush, while encouraging production of more milk in fall.

The common purpose of the two seasonal pricing plans is to offer an economic incentive to encourage less seasonality of milk production. Each seasonal pricing plan has its advantages and shortcomings. Nevertheless, experience in various markets indicates these plans have achieved some success in reducing seasonal fluctuation of milk production.

However, the two seasonal pricing plans do not address the problem of how cooperatives can determine and recover costs of handling seasonal milk deliveries by producers, so cooperatives can stay in financial health.

The other related problem is how cooperatives should charge handlers for satisfying their fluid demand and balancing milk supply. Fluid demand, though relatively more stable than the production pattern throughout the year, has its own seasonality. It is higher in early spring and fall than during the summer, resulting in a fluctuating volume of milk going into a cooperative's manufacturing plants. In addition, there are day-to-day fluctuations in supplying the needs of fluid plants that affect both milk hauling and milk manufacturing operations.

As more and more cooperatives engage in full-service operations, pricing plans are needed to manage milk deliveries for the cooperatives to achieve overall efficiency and maintain least-cost operations. How should such pricing plans be designed? What form should the pricing plans take? What are the cost-justified and equitable charges on seasonal excess milk? What is the cost-justified difference between prices to handlers for uniform daily fluid demand during a week and certain daily fluctuations? This study attempts to provide answers to these and other related questions.

To answer these questions, a hypothetical model ABC Cooperative was devised. It is a full-service cooperative, responsible for picking up members' milk and delivering it to fluid processing plants. Milk in excess of fluid uses is manufactured into butter and nonfat dry milk at the cooperative's own plant.

SEASONAL NATURE OF MILK PRODUCTION, CONSUMPTION, AND MANUFACTURING

The assumed index of seasonality of ABC Cooperative members' milk production is presented in table 1. The seasonal index shows March, April, May, and June are usually the highest milk-producing months, with May as the peak. The index of 110 indicates average daily production in May is 10 percent higher than annual average daily production (average index = 100). Production declines sharply from June to July and stays relatively low throughout summer and fall. Production is usually lowest in November. With an index of 93, November is 7 percent below annual average daily production. Production recovers in December and increases steadily through winter and spring until it peaks again in May. The May peak to November trough is a drop of 17 percentage points, based on average daily production. On an actual daily production basis, the peak to trough discrepancy would have been even greater.

The seasonal pattern of fluid demand facing ABC Cooperative is quite different (table 1). Fluid demand is high in September and maintains this high level through fall and winter. It peaks in November (seasonal index = 104), which is 4 percent above annual average daily consumption (average index = 100). Fluid demand dips in December and declines steadily from February. The lowest fluid demand month is July. With an index of 92, it is 8 percent below the annual daily average. The July low is a drop of 12 percentage points compared with the November peak.

Suppose the cooperative's annual average daily milk production is 4 million pounds and, on the average, 50 percent of the milk is sold for fluid uses. Then the cooperative members' total milk production, along with milk shipped to fluid processing plants and that left over for manufacturing, can be shown as in table 2 and in figure 1. Daily milk production decreases from the peak, 4.4 million pounds in May, to 3.72 million pounds in November, and increases again starting December. Fluid demand for the cooperative's milk is at a peak 2.08 million pounds a day in November and decreases to 1.84 million pounds in July.

Table 1—Indices of seasonality of milk production and fluid demand facing ABC Cooperative

Month	Milk production	Fluid demand
January	98	103
February	99	102
March	104	101
April	108	98
May	110	100
June	109	97
July	98	92
August	96	95
September	96	103
October	94	103
November	93	104
December	95	102
Average	100	100

Milk used in manufacturing is the volume left over after satisfying fluid demand. Daily volume for manufacturing peaks in June and is at its lowest volume in November, fluctuating from 2.42 million pounds per day to 1.64 million pounds.

Beside the annual cycle of fluid uses, processing plants have a weekly cycle of fluid demand. Typically, fluid processing plants do not operate 7 days a week. Their receipts of fluid milk tend to gear to their operating schedules.[1]

Weekly variation of fluid demand by processing plants is estimated in table 3. Sunday fluid demand is 8 percent of weekly total demand. The demand for Wednesday increases to 17.3 percent of weekly total demand. Demand drops sharply on Thursday but peaks on Friday. Saturday fluid demand is almost equal to weekly average daily demand. Expressed as a percent of weekly average daily demand, indices of daily demand are also listed in table 3. The index for Sunday is 56; Wednesday, 121; Thursday, 82; Friday, 128; Saturday, 101.

Given the cooperative's seasonal cycle of milk production and seasonal as well as weekly cycles of fluid demand, the stage is set for assessing costs associated with the cyclical fluctuations. Hauling and manufacturing costs, two major cost items for a full-service cooperative, are discussed.

Seasonal Milk Delivery and Hauling Cost

The impact of seasonal milk production on hauling cost mainly involves the fixed cost portion of total hauling cost. Fixed hauling costs consist of equipment costs and overhead such as insurance, taxes, licenses, and administration. Using the method developed by Agricultural Cooperative Service[2] the fixed hauling cost was estimated and is shown

[1] B. J. Smith, H. B. Metzger, and F. A. Lasley, *Fluid Milk Reserves and Production-Consumption Balances in Northeastern United States*, Pennsylvania Agricultural Experiment Station, May 1978. Table 1 of the publication provides a sample of pasturization schedules.

[2] J. B. Roof and G. C. Tucker, *An Equitable Charge and Payment System for Least-Cost Milk Assembly in Indiana*, Farmer Cooperative Service, Service Report No. 127. USDA, July 1972.

Figure 1

Milk Production, Fluid Demand and Milk for Manufacturing, ABC Cooperative

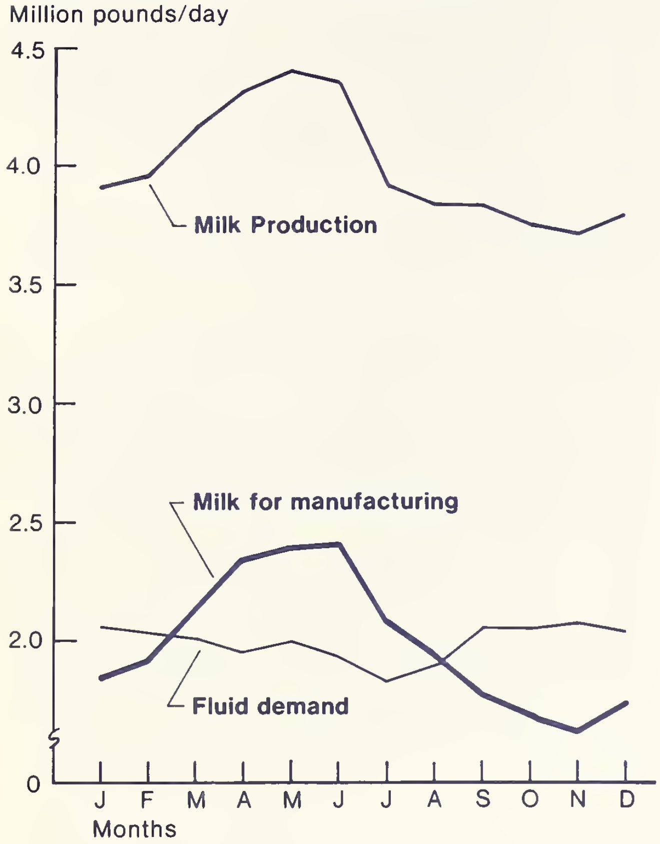


Table 2—ABC Cooperative's daily volumes of milk production, fluid demand, and milk for manufacturing, by month

Month	Milk production	Fluid demand	Milk for manufacturing
	Million pounds per day		
January	3.92	2.06	1.86
February	3.96	2.04	1.92
March	4.16	2.02	2.14
April	4.32	1.96	2.36
May	4.40	2.00	2.40
June	4.36	1.94	2.42
July	3.92	1.84	2.08
August	3.84	1.90	1.94
September	3.84	2.06	1.78
October	3.76	2.06	1.70
November	3.72	2.08	1.64
December	3.80	2.04	1.76
Average	4.00	2.00	2.00

Table 3—Handlers' weekly cycle of fluid demand on ABC Cooperative's milk, an average week in May

Day	Percent of weekly demand	Weekly cycle index	Daily average production	Daily fluid demand	Milk for manufacturing
			Million pounds per day		
Sunday	8.0	56	4.40	1.12	3.28
Monday	13.2	93	4.40	1.86	2.54
Tuesday	16.9	119	4.40	2.38	2.02
Wednesday	17.3	121	4.40	2.42	1.98
Thursday	11.8	82	4.40	1.64	2.76
Friday	18.4	128	4.40	2.56	1.84
Saturday	14.4	101	4.40	2.02	2.38
Average	14.3	100	4.40	2.00	2.40

in table 4. Equipment cost was based on a tank truck of 48,160-pound (5,600-gallon capacity) for hauling milk for 7 years. Annual equipment cost was calculated using an annual interest rate of 15 percent. Total annual fixed cost of equipment and overhead was estimated at $23,950 per tank truck per year.

ABC Cooperative (or its contract hauler[3]) has to possess 91 tank trucks year round to meet peak hauling requirements in May, while milk production fluctuates below the peak volume during other months. In other words, except in May, there is underutilized hauling capacity (called under-employment or disguised unemployment in economics) necessitated by the peak volume of milk production. The cost of possessing underutilized capacity should be borne by the milk volume that causes the problem. An equivalent way of calculating such cost is to vary the number of tank trucks with milk volume. Starting with the month of lowest milk production, the number of tank trucks necessary to haul the milk increases with the increase in milk production. Costs of extra tank trucks can then be attributed to additional volumes of milk produced. Assume when a tank-truck is employed, it is used to haul one load per day at its capacity volume.

To haul the seasonal minimum delivery of 3.72 million pounds per day, 77 tank trucks are required. At an annual fixed cost of $23,950 per tank-truck, they will have a total fixed cost of $1,844,150. Used every day of the year, they will have a total fixed cost of $5,052 a day. Divided by 3.72 million pounds, unit fixed cost amounts to 13.58 cents per hundredweight of milk.

Fixed costs of the 78th-91st tank trucks are borne by the milk volume they haul and calculated in the same way.

[3]Contract haulers would shift the cost of tank truck ownership to milk producers.

Table 5 shows the calculation of the per-hundredweight hauling cost of milk in excess of seasonal minimum delivery. The peak production month of May requires 91 tank trucks to haul the milk, or 14 more than November. Unit fixed hauling cost per hundredweight of milk in excess of seasonal minimum delivery (3.72 million pounds a day) is 40.35 cents per hundredweight in May. Unit fixed hauling cost for above-minimum milk volume during other months is also shown in table 5. The cost ranges from 17.60 cents in January and July to 42.88 cents in June. It is from 4.02 cents to almost 30 cents per hundredweight higher than the seasonal minimum fixed cost of 13.58 cents.

The calculation in table 5 clearly shows the extra hauling cost associated with handling seasonal milk delivery.

Seasonal Milk Delivery and Manufacturing Cost

In addition to affecting hauling cost, seasonal fluctuation of milk deliveries also affects the cost of the cooperative's balancing operation of manufacturing milk in excess of fluid uses into storable hard products. As with hauling costs, impact of seasonal fluctuation on manufacturing costs largely involves the fixed portion of the plant's total cost.

Before calculating manufacturing cost, the size of the cooperative's manufacturing plant must be decided. The manufacturing plant has the option of operating 7 or fewer days a week but is supposed to use up weekly volume of milk available for manufacturing during the week. Under normal conditions, a manufacturing plant is assumed to operate 6 days a week (3 shifts, 20 machine-hours a day).

In table 2, average daily volume of milk available for manufacturing was listed for each month. Table 6 translates this into milk volume that has to be manufactured per day when the plant operates on a 6-day week.

Table 4—Computation of fixed hauling cost per tank truck, ABC Cooperative

Item	Estimated present value	Estimated salvage value after 7 years	Use capital	Capital recovery factor or annual interest rate	Annual cost
		Dollars		*Percent*	*Dollars*
Truck	50,000	5,000	45,000	24.0360	10,816
Tank (48,160 pound capacity)	37,500	12,500	25,000	24.0360	6,009
		17,500T		15	2,625
Taxes, licenses, insurance, and administration					4,500
					23,950T

T = Column total

Table 5—Fixed hauling cost borne by milk volume in excess of seasonal minimum delivery, ABC Cooperative

Month	Milk production	of tank truck	Fixed cost[1]									Fixed hauling cost for milk in excess of minimum delivery	
			78th tank truck	79th tank truck	80th tank truck	81st tank truck	82nd tank truck	83rd-86th tank trucks	87th-90th tank trucks	91st tank truck	Total cost	Unit cost	Unit cost above minimum
	Million lbs per day	*Number*	*Dollars per day*									*Cents per cwt.*	
January	3.92	81	72	79	88	113	—	—	—	—	352	17.60	4.02
February	3.96	82	72	79	88	113	160	—	—	—	512	21.33	7.75
March	4.16	86	72	79	88	113	160	786	—	—	1,298	29.50	15.92
April	4.32	90	72	79	88	113	160	786	1,053	—	2,351	39.18	25.60
May	4.40	91	72	79	88	113	160	786	1,053	393	2,744	40.35	26.77
June	4.36	91	72	79	88	113	160	786	1,053	393	2,744	42.88	29.30
July	3.92	81	72	79	88	113	—	—	—	—	352	17.60	4.02
August	3.84	80	72	79	88	—	—	—	—	—	239	19.92	6.34
September	3.84	80	72	79	88	—	—	—	—	—	239	19.92	6.34
October	3.76	78	72	—	—	—	—	—	—	—	72	18.00	4.42
November	3.72	77	—	—	—	—	—	—	—	—	0	—	—
December	3.80	79	72	79	—	—	—	—	—	—	151	18.88	5.30

[1]Average daily fixed cost of the first 77 tank trucks to haul 3.72 million pounds of minimum delivery per day is $5,052, or 13.58 cents per hundredweight of milk.

Plant capacity should be higher than the peak volume of milk to be manufactured. Table 6 shows the peak volume to be manufactured is 2.82 million pounds per day in June. To handle the volume, a manufacturing plant with a rated capacity of 3 million pounds a day is required. The plant is estimated to cost almost $13 million (table 7). At a 15-percent interest rate, annual total cost of land, building, machinery, and equipment amounts to more than $2.3 million. Adding to this the estimated overhead of taxes, licenses, insurance, and administrative cost, total annual fixed cost (including overhead) is estimated at more than $3 million. Total fixed cost equals $8,298 a calendar day and for a 6-day week, $9,681 for every operating day.

On a per-hundredweight basis, fixed cost is more than 32 cents at the capacity volume of 3 million pounds of milk a day (table 8) and increases at an increasing rate as the milk volume manufactured per day decreases. At 2 million pounds a day, it is 48.41 cents per hundredweight and at 1 million pounds, about 97 cents.

Table 6—Daily milk volume for manufacturing 6 days a week, ABC Cooperative

Month	Milk volume
	Million pounds per day
January	2.17
February	2.24
March	2.50
April	2.75
May	2.80
June	2.82
July	2.43
August	2.26
September	2.08
October	1.98
November	1.91
December	2.05

Table 7—Annual fixed and overhead cost for a 3-million-pound-per-day butter-powder manufacturing plant

Item	Estimated present value	Estimated years of use	Estimated salvage value	Use capital	Capital recovery factor or annual interest rate	Annual cost
	Dollars	*Number*	*Dollars*		*Percent*	*Dollars*
Land	114,000	—	—	114,000	15	17,100
Building	4,560,000	20	456,000	4,104,000	15.9761	655,659
Machinery and equipment	7,980,000	10	798,000	7,182,000	19.9252	1,431,028
Automobile, fixtures, etc.,	228,000	7	22,800	205,200	24.0360	49,322
			1,276,800T		15	191,520
Taxes, licenses, insurance, and administration						684,000
						3,028,629T

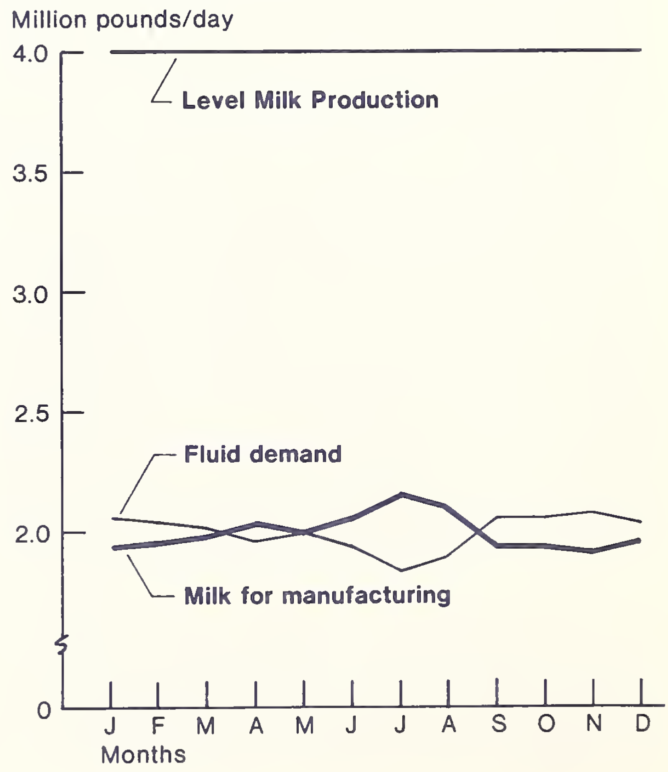
T = Column total

Table 8—Unit fixed cost for a 3-million-pound-per-day butter-powder manufacturing plant

Milk volume per day	Unit fixed cost
Pounds	*Cents per hundredweight of milk*
3,000,000	32.27
2,900,000	33.38
2,800,000	34.58
2,700,000	35.86
2,600,000	37.24
2,500,000	38.72
2,400,000	40.34
2,300,000	42.09
2,200,000	44.01
2,100,000	46.10
2,000,000	48.41
1,900,000	50.95
1,800,000	53.78
1,700,000	56.95
1,600,000	60.51
1,500,000	64.54
1,400,000	69.15
1,300,000	74.47
1,200,000	80.68
1,100,000	88.01
1,000,000	96.81

Figure 2

Level Milk Production, Fluid Demand and Milk for Manufacturing, ABC Cooperative



ALTERNATIVE CASE ONE: LEVEL MILK DELIVERIES

Assume milk deliveries by ABC Cooperative's members are the same 4 million pounds a day as in the previous case, but without any fluctuation. Fluid milk deliveries by ABC Cooperative to handlers also remain the same. Milk volume left over for manufacturing purposes is shown in table 9. Daily volume in excess of fluid uses shows less fluctuation than in the previous case, ranging from 1.92 to 2.16 million pounds a day, compared with 1.64 to 2.42 million pounds a day under the existing production pattern (table 2). The difference is illustrated by comparing figures 1 and 2.

Hauling Cost

Level milk deliveries require ABC Cooperative to constantly handle 4 million pounds a day. The volume of milk requires 83 tank trucks for the hauling function. At a fixed cost of $23,950 per tank truck, total fixed cost of 83 tank trucks is $1,987,850. On a per-hundredweight basis, hauling cost is a constant 13.62 cents.

Manufacturing Cost

Milk volume available for a 6-day manufacturing schedule resulting from level milk deliveries is also listed in table 9. A manufacturing plant with a rated capacity of 2.7 million pounds a day is required to handle the peak volume of 2.52 million pounds a day in July. The plant is estimated to cost about $12 million. Total annual fixed cost is estimated at $2.8 million (table 10). Unit fixed cost for a plant of this size is calculated in table 11.

ALTERNATIVE CASE TWO: MILK PRODUCTION CONFORMING TO FLUID DEMAND

Another alternative is where milk production is maintained at a level higher than fluid demand by a constant volume. The constant flow, year round, of an assumed steady volume of milk for manufacturing should theoretically alleviate problems caused by a fluctuating volume of milk at the plant.

In this hypothetical case, milk volume for manufacturing is maintained at 2 million pounds a day year round (table 12

Table 9—Daily volumes of milk production, fluid demand, and milk for manufacturing under level milk production

Month	Daily average production	Fluid demand	Daily volume of milk for manufacturing: On 7-day schedule	Daily volume of milk for manufacturing: On 6-day schedule
	Million pounds per day			
January	4.00	2.06	1.94	2.26
February	4.00	2.04	1.96	2.29
March	4.00	2.02	1.98	2.31
April	4.00	1.96	2.04	2.38
May	4.00	2.00	2.00	2.33
June	4.00	1.94	2.06	2.40
July	4.00	1.84	2.16	2.52
August	4.00	1.90	2.10	2.45
September	4.00	2.06	1.94	2.26
October	4.00	2.06	1.94	2.26
November	4.00	2.08	1.92	2.24
December	4.00	2.04	1.96	2.29
Average	4.00	2.00	2.00	2.33

Table 10—Annual fixed and overhead cost for a 2.7-million-pound-per-day butter-powder manufacturing plant

Item	Estimated present value	Estimated years of use	Estimated salvage value	Use capital	Capital recovery factor or annual interest rate	Annual cost
	Dollars	*Number*	*Dollars*		*Percent*	*Dollars*
Land	105,600	—	—	105,600	15	15,840
Building	4,224,000	20	422,400	3,801,600	15.9761	607,347
Machinery and equipment	7,392,000	10	739,200	6,652,800	19.9252	1,325,584
Automobile, fixtures, etc.,	211,200	7	21,120	190,080	24.0360	45,688
			1,182,720T		15	177,408
Taxes, licenses, insurance, and administration						633,600
						2,805,467T

T = Column total

Table 11—Unit fixed cost for a 2.7-million-pound-per-day butter-powder manufacturing plant

Milk volume per day	Unit fixed cost
Pounds	*Cents per hundredweight of milk*
2,700,000	33.21
2,600,000	34.49
2,500,000	35.87
2,400,000	37.36
2,300,000	38.99
2,200,000	40.76
2,100,000	42.70
2,000,000	44.84
1,900,000	47.20
1,800,000	49.82
1,700,000	52.75
1,600,000	56.04
1,500,000	59.78
1,400,000	64.05
1,300,000	68.98
1,200,000	74.73
1,100,000	81.52
1,000,000	89.67
900,000	99.63
800,000	112.09
700,000	128.10

Figure 3

Milk Production Conforming to Fluid Demand and Milk for Manufacturing, ABC Cooperative

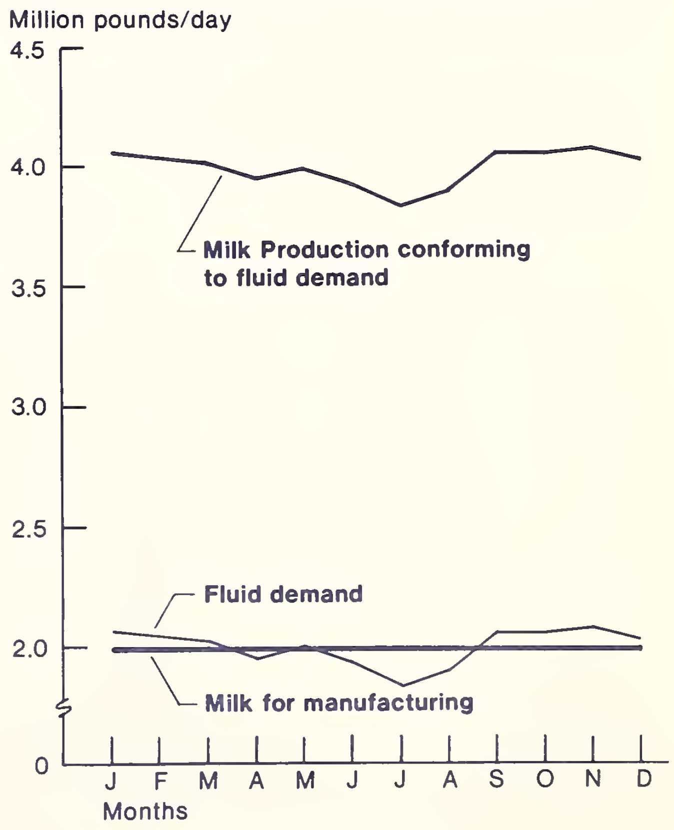


Table 12—Daily volumes of milk production, fluid demand, and milk for manufacturing when milk production conforms to fluid demand

Month	Milk production	Fluid demand	Daily volume of milk for manufacturing: On 7-day schedule	Daily volume of milk for manufacturing: On 6-day schedule
		Million pounds per day		
January	4.06	2.06	2.00	2.33
February	4.04	2.04	2.00	2.33
March	4.02	2.02	2.00	2.33
April	3.96	1.96	2.00	2.33
May	4.00	2.00	2.00	2.33
June	3.94	1.94	2.00	2.33
July	3.84	1.84	2.00	2.33
August	3.90	1.90	2.00	2.33
September	4.06	2.06	2.00	2.33
October	4.06	2.06	2.00	2.33
November	4.08	2.08	2.00	2.33
December	4.04	2.04	2.00	2.33
Average	4.00	2.00	2.00	2.33

Table 13—Annual fixed and overhead cost for a 2.5-million-pound-per-day butter-powder manufacturing plant

Item	Estimated present value	Estimated years of use	Estimated salvage value	Use capital	Capital recovery factor or annual interest rate	Annual cost
	Dollars	*Number*	*Dollars*		*Percent*	*Dollars*
Land	100,000	—	—	100,000	15	15,000
Building	4,000,000	20	400,000	3,600,000	15.9761	575,140
Machinery and equipment	7,000,000	10	700,000	6,300,000	19.9252	1,255,288
Automobile, fixtures, etc.,	200,000	7	20,000	180,000	24.0360	43,245
			1,120,000T		15	168,000
Taxes, licenses, insurance, and administration						600,000
						2,656,673T

T = Column total

and figure 3). Given the assumed fluid demand, this volume will result in annual average milk production at the same 4 million pounds a day as in the previous two cases. Daily milk production for each month is listed in table 12, along with fluid demand and milk for manufacturing on a 6-day schedule. Daily milk production in this case ranges from 3.84 million pounds in July to 4.08 million pounds in November. Milk for manufacturing is at a constant 2-million-pound daily volume and at a constant 2.33 million pounds on a 6-day operating schedule.

Hauling Cost

To handle the peak 4.08 million pounds of milk per day, the cooperative needs to own 85 tank trucks. To haul the July production of 3.84 million pounds a day requires 80 tank trucks. Therefore, there will be some underutilized tank-truck capacity during the off-peak season. This, again, affects unit fixed hauling cost, calculated the same as under the existing production pattern shown in table 5. Annual fixed cost of 85 tank trucks is $2,035,750.

Table 14—Unit fixed cost for a 2.5-million-pound-per-day butter-powder manufacturing plant

Milk volume per day	Unit fixed cost
Pounds	*Cents per hundredweight of milk*
2,500,000	33.97
2,400,000	35.38
2,300,000	36.92
2,200,000	38.60
2,100,000	40.44
2,000,000	42.46
1,900,000	44.70
1,800,000	47.18
1,700,000	49.95
1,600,000	53.08
1,500,000	56.01
1,400,000	60.66
1,300,000	65.32
1,200,000	70.77
1,100,000	77.20
1,000,000	84.92
900,000	94.36
800,000	106.15
700,000	121.31
600,000	141.53
500,000	169.84

Manufacturing Cost

A manufacturing plant with a capacity of 2.5 million pounds a day, somewhat smaller and less expensive than the plant in alternative one, is suitable for handling the volume of 2.33 million pounds of milk for manufacturing on a 6-day schedule. A manufacturing plant of this size will cost about $11 million (table 13). Total annual fixed cost is about $2.6 million. Unit fixed cost is calculated in table 14.

COST COMPARISONS OF THE THREE SEASONAL PATTERNS OF MILK PRODUCTION

The three previous sections examined hauling costs and manufacturing costs associated with the three seasonal patterns of milk production. Although the seasonal patterns were different, volume of annual production was kept the same in each case, averaging 4 million pounds a day. Fluid demand and its seasonal pattern were exactly the same in the three cases. The purpose of the exercise was to single out the impacts of seasonal milk production on hauling and manufacturing costs.

Only the fixed portions of the hauling and manufacturing costs were studied. Total fixed cost is a fixed charge or outlay regardless of volume handled. Per-unit fixed cost thus varies with the hundredweights of milk hauled and manufactured. Total variable cost varies in proportion to the volume. Per-unit variable cost is theoretically constant. For these reasons, the analysis concentrates on examining the fixed cost (including overhead).[4]

Hauling Cost

Annual fixed costs for the three seasonal patterns of production are summarized in table 15. The existing production pattern requires 91 tank trucks to haul the peak volume. At a fixed cost of $23,950 per tank truck, total annual fixed cost is $2,179,750. This is eight tank trucks more than required to haul level volume of production at an extra cost of $191,600 a year. This is an extra cost of 1.31 cents per hundredweight of the 1,460 million pounds of milk delivered by ABC Cooperative's members.

To haul the peak volume in a pattern of production conforming to fluid demand requires two more tank trucks than under a pattern of level production. The extra fixed cost is $47,900 or 0.33 cent per hundredweight.

[4]From a practical operating viewpoint, some plant operating costs are semifixed, such as fuel for heating, or semivariable, such as retained skilled labor. But for purposes of this study, all costs are separated into fixed and variable components.

Table 15—Comparison of fixed hauling cost under three seasonal patterns of milk production

Item	Existing production	Level production	Production conforming to fluid demand
Number of tank trucks required	91	83	85
		Dollars	
Annual fixed cost	2,179,450	1,987,850	2,035,750
Difference from minimum fixed cost	191,600	—	47,900
Per hundredweight difference	.0131	—	.0033

Table 16—Comparison of fixed manufacturing costs under three seasonal patterns of milk production

Item	Existing production	Level production	Production conforming to fluid demand
Rated plant capacity (million lbs./day)	3.0	2.7	2.5
		Dollars	
Annual fixed cost	3,028,629	2,805,467	2,656,673
Difference above minimum	371,956	148,794	—
Per hundredweight difference	.0255	.0102	—

From the standpoint of the cooperative's hauling operation, level milk production is the most desirable seasonal pattern.

Manufacturing Cost

Under the existing pattern of milk production, the manufacturing plant with a rated capacity of 3 million pounds a day has an annual fixed cost of $3,028,629. This annual fixed cost is $371,956 or 2.55 cents per hundredweight higher than that of the manufacturing plant in the case of production conforming to fluid demand (table 16).

Level production pattern requires a plant manufacturing 2.7 million pounds a day at an annual fixed cost of $2,805,467, or $148,794 higher than a plant manufacturing 2.5 million pounds under the pattern of production conforming to fluid demand.

From the viewpoint of the cooperative's manufacturing operation, the case of production conforming to fluid demand is most desirable.

The Most Desirable Seasonal Pattern of Milk Production for Hauling and Manufacturing Operations

When both hauling and manufacturing operations are considered together, the seasonal pattern of milk production conforming to fluid demand emerges as the most desirable case. The existing production pattern has a cost disadvantage of $515,656 or 3.53 cents per hundredweight (table 17). Level production costs $100,894 more than the ideal pattern of production conforming to fluid demand.

Having established the case of production conforming to fluid demand as the most desirable pattern for hauling and manufacturing operations, two important questions remain:

- Given the seasonal pattern of milk prices—generally lower in spring and higher in fall—would a seasonal pattern of milk production conforming to fluid demand reduce farmer-members' annual income?
- Is the pattern feasible, given the biological nature of dairy cows?

Table 17—Comparison of fixed hauling and manufacturing costs under three seasonal patterns of milk production

Item	Existing production	Level production	Production conforming to fluid demand
		Dollars	
Fixed and other costs			
Hauling	2,179,450	1,987,850	2,035,750
Manufacturing	3,028,629	2,805,467	2,656,673
Total	5,208,079	4,793,317	4,692,423
Difference above minimum	515,656	100,894	—
Per hundredweight difference	.0353	.0069	—

Table 18—Standardized lactation curve with adjustments for month of calving

Daily milk production during month in lactation		Adjustments for month of calving	
Month	Pounds per day	Month	Pounds per day
First	54.33	January	0.67
Second	52.92	February	1.59
Third	49.30	March	2.05
Fourth	45.89	April	2.95
Fifth	43.04	May	4.41
Sixth	40.14	June	4.19
Seventh	37.16	July	2.89
Eighth	33.52	August	1.32
Ninth	29.86	September	.78
Tenth	26.50	October	.14
Eleventh	Dry	November	−.35
Twelfth	Dry	December	0

Source: George Wiggans, "Standardized Lactation Curves Adjusted for Month of Calving." Unpublished manuscript, Animal Improvement Laboratory, Beltsville, Maryland. 1979.

Because milk price is generally lower in spring and higher in fall, other things being equal, production conforming to fluid demand would improve farmer-members' annual income, compared with the existing seasonal pattern of production.

Milk production conforming to fluid demand appears feasible, according to a recently developed standardized lactation curve (table 18).[5] The standardized lactation curve indicates a cow, on the average, produces 54.33 pounds of milk a day during the first month of lactation. Production declines steadily until the cow dries up during the tenth month of lactation. However, a cow's milk production has to be adjusted by the month of calving. If a cow freshens in May, 4.41 pounds of milk production per day is added to the standardized lactation curve. Therefore, a May freshening cow produces 13,920 pounds of milk per lactation. For a November freshening cow, 0.35 pound of milk production per day is subtracted from the standardized lactation curve, producing a total of 12,420 pounds of milk per lactation.

With careful management, a desirable milk production pattern can be achieved. Table 19 lists a schedule of freshening cows for producing milk in a seasonal pattern conforming to fluid demand. If members of ABC Cooperative col-

[5]Adopted in A. M. Prindle and J. S. Livezey, "Optimal Production Schedules for a Representative Farm Under Alternative Seasonal Milk Pricing Patterns of the Base-Excess Plan", *Journal of the Northeastern Agricultural Economics Council*, April 1981, table 1, page 27.

lectively freshen 7,999 cows in April and then follow the schedule, milk production can be expected to conform to the seasonal pattern of fluid demand from the following Janaury on.

The schedule of freshening cows on table 19 is based on a linear programming optimal solution. The solution assumes there is no cost difference for freshening cows in different months. Extra farm operation cost might be incurred for having cows freshen in certain months for a desirable pattern of milk production. Adequate cost information is lacking on this subject, however.

PRICING PLAN FOR MANAGING PRODUCERS' SEASONAL MILK DELIVERIES

The guiding principle for designing pricing plans for ABC Cooperative to manage milk deliveries is one of service at cost. Handling charges to producers should be based on the degree to which their individual deliveries tax the handling system of ABC Cooperative. Similarly, ABC Cooperative should charge handlers the full cost of servicing their needs when it delivers a required milk volume at the right time.

Milk production conforming to fluid demand, shown to incur the lowest hauling and manufacturing costs, serves as the benchmark for designing a producer pricing plan. The discussion will center on the existing seasonal pattern of milk production as compared with the benchmark.

Hauling Cost Component

As shown earlier (table 15), milk production conforming to fluid demand requires 85 tank trucks. The existing pattern of production would produce the same 1,460 million pounds a year but would require 91 tank trucks (table 20). The 85 tank trucks can haul 4.09 million pounds of milk a day and should be sufficient to haul the milk except during the 4 peak production months of March through June. At a fixed cost of $23,950 per tank truck per year, the basic 85 tank trucks would cost $2,035,750 a year. Distributed among the 1,433.22 million pounds of milk hauled, the basic unit fixed cost is 14.20 cents per hundredweight. The basic unit fixed cost applies to all the milk except 70,000 pounds a day in March, 230,000 pounds a day in April, 310,000 pounds a day in May, and 270,000 pounds a day in June. March requires one more tank truck; April, five more; and May and June each, six more. Unit fixed cost to haul milk in excess of 4.09 million pounds a day is 28 cents per hundredweight in March, 54.30 cents in April, 52.97 cents in May, and 60.81 cents in June. Weighted average unit fixed cost for the 26.78 million pounds seasonal excess milk is 53.66 cents per hundredweight, 39.46 cents higher than the basic unit fixed cost of 14.20 cents (table 20).

Table 19—Schedule of freshening cows to produce milk volume conforming to fluid demand

Month	Number of cows freshening
January	10,016
February	8,547
March	9,518
April	7,999
May	9,507
June	8,160
July	8,507
August	9,828
September	12,239
October	8,830
November	10,214
December	8,486

Other things being equal, a pricing plan for ABC Cooperative to equitably charge its members for hauling should levy an extra 13.80 cents per hundredweight on the milk in excess of 4.09 million pounds a day in March, 40.10 cents in April, 38.77 cents in May, and 46.61 cents in June. The extra hauling charge also could be a flat weighted average 39.46 cents per hundredweight of all the seasonal excess milk.

Manufacturing Cost Component

The existing milk production pattern requires a manufacturing plant of 3.0 million pounds' rated capacity, which incurs $371,956 higher fixed cost than the 2.5-million-pound plant required under the ideal production pattern conforming to fluid demand (table 16). The higher cost is caused by seasonal excess volumes of milk production in March through July (table 21): 140,000 pounds a day in March, 360,000 pounds a day in April, 400,000 pounds a day in May, 420,000 pounds a day in June, and 80,000 pounds a day in July, with an annual total excess volume of 42.62 million pounds. The higher fixed manufacturing cost of $371,956, allocated to the 42.62 million pounds of seasonal excess milk, amounts to 87.27 cents per hundredweight. Therefore, an equitable pricing plan should charge an extra 87.27 cents per hundredweight of seasonal excess milk for the extra manufacturing cost incurred from seasonal production during March through July.

Table 20—Fixed hauling cost borne by milk volume in excess of the ideal pattern of production

Month	Milk production	Number of tank trucks, 85 minimum	Fixed cost[1]: 86th tank truck	87-90th tank trucks	91st tank truck	Total fixed cost in excess of 85 tank trucks	Unit fixed cost for milk in excess of the ideal pattern	Unit fixed cpst in excess of basic unit fixed costs
	Million lbs per day	*Number*	*Dollars per day*				*Cents per hundredweight*	
January	3.92	85						
February	3.96	85						
March	4.16	86	196			196	28.00	13.80
April	4.32	90	196	1,053		1,249	54.30	40.10
May	4.40	91	196	1,053	393	1,642	52.97	38.77
June	4.36	91	196	1,053	393	1,642	60.81	46.61
July	3.92	85						
August	3.84	85						
September	3.84	85						
October	3.76	85						
November	3.72	85						
December	3.80	85						
				(weighted average)			53.66	39.46

[1]Annual fixed cost of 85 tank trucks is $2,035,750 or at the basic unit fixed cost of 14.20 cents per hundredweight of all the milk (1,433.22 million pounds) except 0.07 million pounds per day in March, 0.23 million pounds per day in April, 0.31 million pounds per day in May, and 0.27 million pounds per day in June.

Table 21—Comparison of milk production under the existing seasonal pattern with the ideal seasonal pattern and charges against seasonal excess milk

Month	Existing pattern	Ideal pattern	Seasonal excess volume[1]	Charges on seasonal excess volume when total production: At least 4.09 million pounds	More than 4.09 million pounds[2]
	Million lbs. per day			*Dollars per hundredweight*	
January	3.92	4.06	—	—	—
February	3.96	4.04	—	—	—
March	4.16	4.02	0.14	0.8727	1.01
April	4.32	3.96	.36	.8727	1.27
May	4.40	4.00	.40	.8727	1.26
June	4.36	3.94	.42	.8727	1.34
July	3.92	3.84	.08	.8727	—
August	3.84	3.90	—	—	—
September	3.84	4.06	—	—	—
October	3.76	4.06	—	—	—
November	3.72	4.08	—	—	—
December	3.80	4.04	—	—	—

— not applicable.
[1]Annual total 42.62 million pounds.
[2]Could be a flat charge of $1.27, which includes 87.27 cents for manufacturing and (a weighted average) 39.46 cents for hauling.

Pricing Plan for Managing Producers' Seasonal Deliveries

To fully recover the costs incurred in its manufacturing operation, ABC Cooperative should calculate a charge on members' seasonal excess milk at 87.27 cents per hundredweight. For milk volumes in excess of 4.09 million pounds a day, additional charges for hauling should be added (table 21). As a result, extra charges per hundredweight on volumes in excess of 4.09 million pounds are: $1.01 in March, $1.27 in April, $1.26 in May, and $1.34 in June. The extra charge can be a flat weighted average of $1.27 per hundredweight, 69 percent of which is for extra manufacturing cost and 31 percent for extra hauling cost.

Charges on seasonal excess milk should be used within ABC Cooperative to defray its hauling and manufacturing costs, rather than be distributed back to producers through the monthly milk pool. These charges would increase the cooperative's net savings (or decrease losses). Increased net savings will be shared by cooperative member-producers through patronage refunds.

This is a different concept from the base-excess plan commonly used in regulated markets. For example, the base-excess plan provisions in Federal Order No. 4 price excess milk at the lower class use (Class II). Base milk shares the remaining market pool. The resulting blend price for base milk is higher than the marketwide blend price would be if all milk were included in the same market pool. Therefore, the base-excess plan penalizes excess milk and rewards base milk.

The pricing plan proposed for ABC Cooperative should not be construed as a method for penalizing or rewarding producers for a particular pattern of milk production, although it may have this effect. Rather, it is designed to offer an equitable means for the cooperative to recover its costs.

To manage its members' seasonal deliveries, ABC Cooperative can combine the pricing plan with the base-excess plan. For example, it can operate a base-excess plan in exactly the same way as under Federal Order No. 4. Excess milk is priced at the lowest class of use. Base milk shares the remaining pool of proceeds. However, excess milk has an additional deduction of 87.27 cents to $1.27 per hundredweight to cover the extra cost of handling it. This extra charge should be kept separated from the producers' milk pool and used to cover ABC Cooperative's operating cost.

Thus, ABC Cooperative's pricing plan for charging seasonal excess milk is similar to, but not the same, as the base-excess plan. The charge is an application of the principle of service at cost. It is also different from a seasonal incentive plan such as the Louisville plan.

PRICING PLANS FOR MANAGING DELIVERIES TO HANDLERS

ABC Cooperative operates the manufacturing plant to balance seasonal and weekend excess milk and manufacture it into butter and powder. Once the plant is built, however, it makes economic sense to operate it at the plant's rated capacity. Milk deliveries to handlers that cause milk volume at the manufacturing plant to fall below its rated capacity should be levied a "give-up" charge, because such deliveries affect the cost structure of manufacturing the milk remaining in the plant.

Suppose the ABC Cooperative manufacturing plant operated at a 3-million-pound capacity, but fluid milk demand by handlers causes 100,000 pounds of milk to be shipped from the plant. Unit fixed cost for the remaining 2.9 million pounds becomes 33.38 cents per hundredweight (table 8), an increase of 1.11 cents over a 32.27-cent-per-hundredweight cost, had the original 3 million pounds been manufactured. The shipment would cost the plant $321.90 (2.9 million pounds at 1.11 cents per hundredweight) in total fixed cost for operating at a lower capacity. When allocated to the 100,000 pounds of milk shipped, there should be a give-up charge of 32 cents per hundredweight. The corresponding give-up charge for a 2.7-million-pound capacity plant is 33 cents per hundredweight (table 11). When the plant's capacity is 2.5 million pounds, the corresponding give-up charge is 34 cents (table 14).

Give-up charges for other volumes of milk may be calculated in the same manner.

Theory

This calculation indicates the give-up charge is exactly the same as the unit fixed cost at the original volume before milk is shipped from the plant. To fully explain this, a brief theoretical digression is necessary.

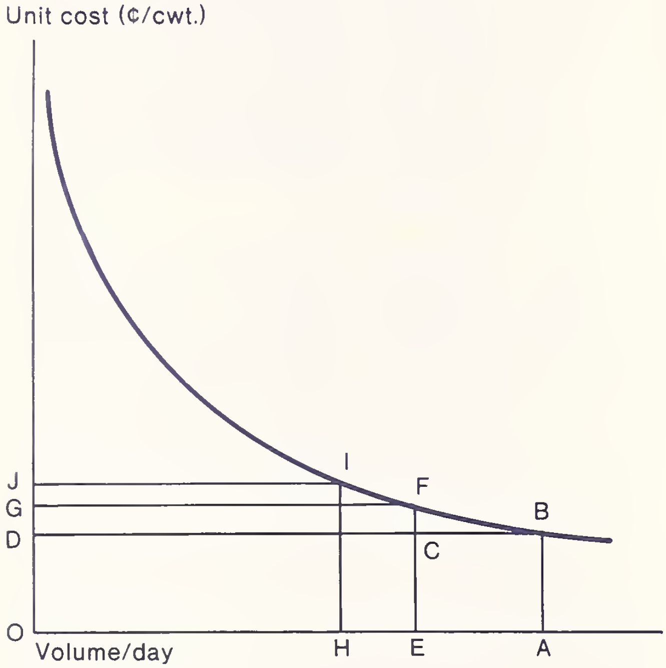
Figure 4 depicts the unit average fixed cost curve (AFC) of ABC Cooperative's manufacturing plant. The concave shape of the AFC curve indicates unit average fixed cost decreases at a decreasing rate as volume increases (or increases at an increasing rate as volume decreases).

Suppose the plant on a typical day manufactured OA volume of milk, at unit fixed cost AB. Total fixed cost on that one day can be represented by the area OABD.

Now the cooperative receives a purchase order, so EA volume of milk has to be shipped from the manufacturing plant. The remaining volume to be manufactured at the plant is OE. Total fixed cost is now represented by OEFG,

Figure 4

Average Fixed Cost Curve, ABC Cooperative Manufacturing Plant



which is equal to OABD, the original fixed cost. Thus, total fixed cost remains the same, while the volume manufactured is smaller, resulting in a unit fixed cost of EF, which is higher than the original unit fixed cost AB or EC by CF. The extra fixed cost to be borne by the remaining volume OE as a result of the milk shipment can be represented by the area DCFG. Since OEFG is equal to OABD, and OECD is common to both areas, it follows that DCFG is equal in area to EABC. In all fairness, the extra fixed cost to be borne by the volume OE as a result of the milk shipment from the plant should be borne by the volume shipped. Therefore, the fixed cost represented by EABC should be charged against EA, the volume shipped, and constitutes what is called a give-up charge. On a per-hundredweight basis, the give-up charge is AB, exactly the same as the unit fixed cost at the original volume before milk diversion.

Give-up Charge

In addition to charging a market price on a volume of diverted milk, a give-up charge should be levied. According to the calculation presented above, the give-up charge is the unit fixed manufacturing cost at the capacity volume: 32 cents per hundredweight for a plant manufacturing 3 million pounds a day, 33 cents for a 2.7-million-pound plant, and 34 cents for a 2.5-million-pound plant.

The requirement to supply milk to the manufacturing plant at the capacity volume and then to levy a give-up charge for any diversion might be argued as too rigid. For example, a 3-million-pound capacity plant might be reasonably operated by maintaining volume at 2.8 million pounds. If this is the case, the give-up charge for the subsequent milk diversion is a higher 35 cents per hundredweight (table 8). Give-up charges can be determined by using table 8, in effect, a give-up charge schedule. Give-up charge schedules for the other two plants are on tables 11 and 14.

The give-up charge discussed thus far is only the basic charge. There are, possibly, other factors that would require further adjustments.

If ABC Cooperative realizes a net margin on sales of manufactured products of its plant, the basic give-up charge may be adjusted upward to include the foregone margin the products might have brought when made with the diverted milk volume. On the other hand, if the manufactured products are sold at a loss, the basic give-up charge may be adjusted downward to the extent of the loss to encourage greater milk sales.

If other plant costs (semifixed costs) do not decrease proportionately with the decrease in volume because of milk diversion, the impact of diversion on these other plant costs should be included also in the give-up charge.

Charges for Day-to-Day Demand Fluctuation

Table 3 shows there is a weekly cycle of fluid demand from day-to-day fluctuation of milk requirements by fluid plants. During an average week in May, for example, even though the daily average fluid demand is 2 million pounds, it ranges from 1.12 million pounds on Sunday to 2.56 million pounds on Friday (table 3 and figure 5). Such day-to-day fluctuation of fluid demand does not have an adverse effect so long as the manufacturing plant has sufficient holding capacity to roll the raw milk stock while maintaining product quality so as to use up available milk for manufacturing each week.

However, the day-to-day fluid demand fluctuation has a potential adverse effect on hauling costs. With a daily average milk production of 4.40 million pounds (table 3) in May, the fluctuation of daily fluid demand within a week results in the milk volume for manufacturing ranging from 3.28 million pounds on Sunday to 1.84 million pounds on Friday. Impact of this volume variation on hauling cost depends on areas from which the milk originates and on relative distances from production areas to fluid demand centers and the manufacturing plant.

Figure 5

Weekly Cycle of Fluid Demand and Resulting Fluctuation of Milk for Manufacturing, An Average Week in May, ABC Cooperative

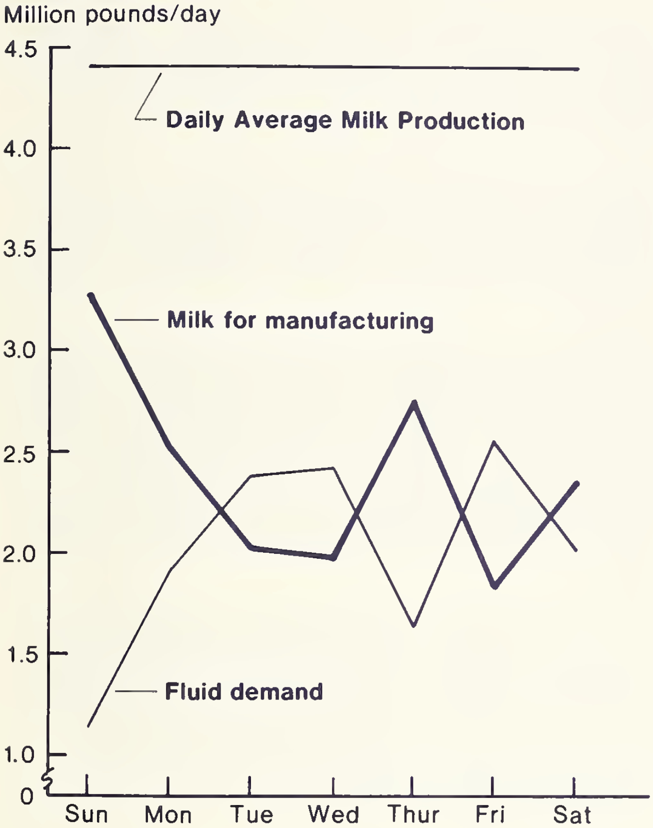


Table 22—Extra hauling cost incurred for hauling milk from fluid supply areas to the manufacturing plant or from fluid reserve-producing areas to fluid demand centers

Day of week	Fluid demand	Milk shipped to/from fluid demand centers	Extra hauling cost
	Million pounds per day		*Dollars per day*
Sunday	1.12	0.88 (from)	2,200
Monday	1.86	.14 (from)	350
Tuesday	2.38	.38 (to)	950
Wednesday	2.42	.42 (to)	1,050
Thursday	1.64	.36 (from)	900
Friday	2.56	.56 (to)	1,400
Saturday	2.02	.02 (to)	50
Weekly total	14.00	2.76	6,900

Figure 6

A Simplified Plant Location Chart

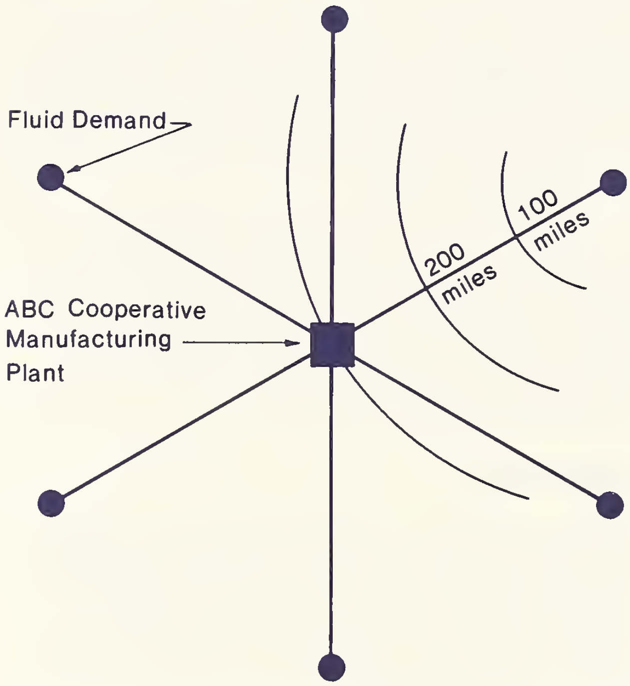


Figure 6 shows a simplified hypothetical location chart of six fluid demand centers and the ABC Cooperative manufacturing plant. The manufacturing plant is centrally located and 300 miles from each fluid demand center.

Suppose total fluid milk volume required at the six fluid demand centers averages 2 million pounds a day, which can be satisfied by milk production from an area averaging 100 miles from each fluid demand center. However, day-to-day fluctuation of fluid demand causes milk from this area to be shipped to and from the manufacturing plant. On a Sunday of an average week in May, because fluid demand is only 1.12 million pounds at the fluid demand centers, 880,000 pounds of milk from the fluid supply area has to be shipped for manufacturing to the plant 200 miles away (table 22). This represents an extra 100 miles hauling distance for the milk shipped. At an estimated cost of 2.5 cents per hundredweight per 10 miles, the extra hauling cost amounts to $2,200. Similar shipments to the manufacturing plant occur on Monday and Thursday, with an extra hauling cost of $350 and $900, respectively.

On Tuesday, fluid demand is 2.38 million pounds or 380,000 pounds more than can be supplied by the ordinary fluid supply area. The additional fluid requirement has to be drawn from the fluid reserve producing area and shipped an average 200 miles to the demand centers. The shipment is

100 miles farther than to its usual destination, the manufacturing plant, and incurs $950 of extra shipping cost. The same method of calculation applies to Wednesday, Friday, and Saturday.

A weekly total volume of 2.76 million pounds has to be shipped 100 miles farther one way or the other because of day-to-day fluctuation of fluid demand, for an additional hauling cost of $6,900. Extra shipping mileage might also cause drivers' scheduling problems or involve overtime wages or some other costs.

ABC Cooperative incurs the extra $6,900 hauling cost per week in May to balance day-to-day fluctuation of fluid demand. For other months, the extra hauling cost can be calculated in the same manner. The extra hauling cost is incurred for servicing the needs of fluid handlers and should be charged against fluid milk.

CONCLUSION

This report describes costs of handling seasonal (cyclical) milk deliveries by dairy cooperatives, both those received from member-producers and those to fluid handlers. For a full-service cooperative, seasonal milk deliveries affect mainly fixed costs of hauling and manufacturing. Manufacturing cost is affected the most.

Based on the principle of service at cost, extra costs of handling seasonal milk should be pinpointed and allocated to the milk volume involved. It is equitable and prudent for cooperatives to charge extra costs to the excess milk volume to recover the full amount of these extra costs. Otherwise, three consequences may arise. First, good performers among member-producers will have to subsidize those who cause the seasonal excess problem. Second, if cooperatives do not fully extract the costs of servicing handlers' fluctuating fluid demands, it might result in member-producers subsidizing handlers who cause the balancing problem. Third, if cooperatives do not attempt to pinpoint and recover these costs, their financial strength might deteriorate in the long run.

Production pattern conforming to fluid demand was considered the ideal seasonal pattern for ABC Cooperative. Seasonal milk in excess of the volume produced under that pattern was determined to require an extra charge of 87.27 cents per hundredweight of the excess milk. Milk volume in excess of 4.09 million pounds a day requires an extra charge of $1.27 per hundredweight, including 39.46 cents for hauling and the same 87.27 cents for manufacturing. This indicates the most serious problem caused by seasonal milk production is the necessity of maintaining sufficient plant capacity to handle peak milk production.

Before a cooperative makes an extra charge on seasonal excess milk, it has to determine the ideal pattern of milk production for the cooperative to handle, given its members' milk volume and extra costs involved in handling the milk in excess of the ideal volume.

The ideal seasonal pattern of milk production determined for ABC Cooperative in this study is based on the given set of data on volumes and costs. It is likely that a different data set may result in a different determination.

Because the data on costs of freshening cows in different months are lacking, the ideal seasonal pattern was determined by assuming uniform cost for freshening cows. The cow freshening cost might possibly vary with the month of freshening.

On deliveries of fluid milk to handlers, there are two possible extra charges involved, in addition to ordinary service charges. A give-up charge should be levied once the fluid demand causes a cooperative's manufacturing plant to operate below its capacity. The give-up charge on the diverted volume of milk should be levied at the same rate as the unit fixed manufacturing cost at the plant's rated capacity.

Day-to-day fluctuation of fluid demand by handlers may cause higher hauling cost. The impact of such fluctuation on hauling cost depends on the distance between the manufacturing plant and the milk supply area and the distance between the milk supply area and fluid demand centers. Careful hauling cost analysis is needed before an extra charge to a handler is determined.

There are some further implications that can be drawn from this study:

- The management of dairy cooperatives should be aware of extra costs involved in handling seasonal deliveries from member-producers. Whether such costs can be recovered through higher charges on seasonal excess milk depends on the foresight and cohesiveness of boards of directors, hired management, and member-producers.

- Levying give-up charges and charges on fluctuating day-to-day fluid demand proposed in this study, though cost justified, may not be possible if the dairy cooperative is in a weak bargaining position. It is imperative that dairy farmers organize strong cooperatives to protect their economic well-being.

- Unless dairy cooperatives are aware of and can recover all costs of handling seasonal supplies from producers and deliveries to handlers, their financial health will be in jeopardy.

* U.S.G.P.O. 522-001/1302-3264

U.S. Department of Agriculture
Agricultural Cooperative Service

Agricultural Cooperative Service provides research, management, and educational assistance to cooperatives to strengthen the economic position of farmers and other rural residents. It works directly with cooperative leaders and Federal and State agencies to improve organization, leadership, and operation of cooperatives and to give guidance to further development.

The agency (1) helps farmers and other rural residents obtain supplies and services at lower costs and to get better prices for products they sell; (2) advises rural residents on developing existing resources through cooperative action to enhance rural living; (3) helps cooperatives improve services and operating efficiency; (4) informs members, directors, employees, and the public on how cooperatives work and benefit their members and their communities; and (5) encourages international cooperative programs.

The agency publishes research and educational materials, and issues *Farmer Cooperatives.* All programs and activities are conducted on a nondiscriminatory basis, without regard to race, creed, color, sex, or national origin.